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LABORATCRY COMPONENT TEST RESULTS AND ANALYSIS OF THE AGM22B MISSILE (FOURTH CYCLE)

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March 1974

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The reliability of AGM22B missiles, after extended environmental exposure, was investigated. Fourth cycle test results and engineering analysis of component degradation, failures and other shortcomings of the missile are discussed in great detail.

Failures and problems that resulted from corrosive actions and which were detected in the previous (third) cycle occurred in greater frequency and severity

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as a result of their additional year of environmental exposure. These defects are still restricted only to the missiles which are stored in the Panama Canal Zone area. One electronic guidance decoder, from an Arctic Test missile, was found to contain a defective transistor which would have seriously affected the pitch command and guidance channel of the missile. Two missiles which had been stored in the Canal Zone were found to have open gyro and rocket motor igniter circuits. Neither of these two missiles would have launched if an attempt was made to fire them at a tactical target.

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US ARMY MATERIEL SYSTEMS ANALYSIS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

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LABORATORY COMPONENT TEST RESULTS AND
ANALYSIS OF THE AGM22B MISSILE (FOURTH CYCLE)

1. INTRODUCTION

The purpose of this study is to determine the reliability of the AGM22B missile based on data resulting from tests performed on its component parts. Laboratory tests were performed on the components of nine missiles. The test sample consisted of three missiles from open storage at the Arctic Test Site, three from open storage at the Tropic Test Site, and three from igloo storage at the Letterkenny Army Depot (LAD).

2. COMPONENT DESCRIPTION AND TESTS PERFORMED

All component tests were comparable to the acceptance tests, therefore acceptance specifications were used as guideline criteria in making engineering judgements. Component descriptions and tests are discussed in the following paragraphs.

2.1 Batteries.

A separate report, "Life Cycle Characteristics of the Batteries for the M22 Antitank Guided Missile,"[1] contains detailed information pertaining to these components.

2.2 Guidance Wire Bobbins.

There are two guidance wire bobbins per missile. The bobbin wires are used to transmit guidance control signals from the guidance control unit (GCU) to the decoder in the missile. The bobbins are wound with 0.012-inch diameter (including insulation covering) steel wire. The wire length is approximately 11,000 feet.

The insulation resistance as well as the actual wire resistance of the bobbin wire is measured. The insulation determination is made while a 200 volt dc potential is applied between the bare wire and the housing. This resistance has a minimum acceptance value of 20 megohms. The guidance wire resistance is specified to be 30,000 $\pm$ 4700 ohms (Ω).

2.3 Flares.

There are two flares per missile. These pyrotechnic devices are electrically ignited at launch and are used to assist the gunner in controlling missile flight.

[1] Kinsey, George O., Vegoda, Ronald J., and Coons, Ronnie L., Life-Cycle Characteristics of the Batteries for the M22 Antitank Guided Missile, AMSAA, Reliability and Maintainability Division Interim Note No. 3, (March 1971) UNCLASSIFIED.

Flare igniter resistance as well as activation current are measured. Luminous intensity of the flares is also recorded. Igniter resistance measurements have an acceptance range of 0.65 to 1.20 Ω, firing current shall not exceed 0.75 amperes (A), and the luminous intensity should be greater than 5,000 candlepower during the period from 0.5 to 21.0 seconds after initiation.

2.4 Wire Release Devices.

There are two wire release devices per missile. These electrically initiated components are used to jettison the control wires after the missile is detonated (when the missile is fired from a helicopter).

Igniter resistance of each release device as well as minimum activation current are measured. The specified range of igniter resistance is 2.05 ± 0.55 Ω, and a maximum activation current less than 0.50 A.

2.5 Explosive Cartridges.

The explosive cartridges, one per missile, are used to release a spring loaded hook that secures the missile in the launcher during transport.

Igniter resistance and activation current are measured. Requirements of resistance are 2.05 ± 0.55 Ω while the activation current must be less than 0.50 A.

2.6 Decoders.

Each decoder receives the coded signal, a composite of both pitch and yaw signals, and converts it into separate pitch and yaw signals. The output transistors of the decoders permit voltage from the missile batteries to be applied to the appropriate jet deflector electromagnets.

In testing the decoders, a mechanical device, to be described in more detail later, permits the control stick of the Guidance Control Unit (GCU) to be moved to standard pitch down, pitch up, yaw left, and yaw right positions. The individual pitch and yaw signals from the control stick potentiometers, the coded output signal of the GCU, and the four output signals from the decoder are simultaneously recorded on an oscillograph. Inspections of the oscillograms permits a determination of how well the decoder responds to known control stick positions. The voltage applied to the decoders in this test is 16 volts dc. This level is 2 volts less than the maximum missile battery voltage.

Decoder output voltages, with a 9 volt input, are measured. This input level is the minimum allowable output for two series-connected batteries. A determination is made as to whether the decoder output to the jet deflector electromagnets is adequate for a minimal input voltage. Peak-to-peak output voltage for this test cannot be less than 7 volts dc. Decoder output is also monitored with a cathode ray oscilloscope for 25 seconds to assure that it operates properly for the entire missile flight time. Decoder input voltage for this tes is 16 volts dc.

2.7 Deflector Assemblies.

Each deflector assembly consists of four pairs of electromagnets spaced 90 degrees around the circumference of the deflector support plate. A jet deflector is mounted between each pair of electromagnets, in a manner that is similar to the armature of a relay. The deflector is drawn into the sustainer motor exhaust when one electromagnet is energized. When its complementary electromagnet is energized, the deflector is withdrawn. The missile decoder applies voltage pulses to the proper electromagnets in response to the signal transmitted from the GCU through the control wires, and the corresponding movement of the jet deflectors in and out of the sustainer jet exhaust controls missile guidance.

The resistance, pull-in voltage, and current of each electromagnetic jet deflector coil is measured. Acceptable resistance readings are 40.0 $\pm$ 3.0 Ω, pull in voltage of each coil is equal to or less than 7.0 volts dc, and pull in current is less than 170 milliamperes.

2.8 Gyroscope and Distributor Assembly.

The AGM22B missile rotates during flight. Pitch and yaw outputs from the decoder must be switched to the particular jet deflector electromagnets that are oriented in space to provide proper pitch and yaw thrusts. Switching is accomplished by the gyroscope and distributor assembly (GDA). The four outputs of the decoder are electrically connected to a circular plate which is divided into four equal sectors or commutators, each being separately insulated. Just prior to launch the gyroscope mass is spun by the detonation of an explosive powder which is installed in the gyro mass. During flight, the rotation of the gyroscope causes the four-sector-commutator-plate to remain fixed in space while four brushes, bearing upon the gyroscope periphery and rotating with the missile, connect the decoder output signals through a slip ring assembly to the jet deflector electromagnets. As the missile rotates, the outputs of the decoder are successively switched to the jet deflector electromagnets whose orientation in space is such that it permits proper pitch and yaw thrusts to be applied. A switch, associated with the solenoid, that uncages the gyroscope, connects the missile batteries to the decoder just before launch.

Gyroscope rotational velocity is measured immediately after ignition of the rotor detonator, and for the ensuing 21-second interval.

Minimum requirements are: a peak rotation of 40,000 rpm and a minimum velocity of 35,000 rpm for a 21-second interval. The resistance of the rotating mass activation detonator has a tolerance range of 2 to 5 Ω and the activation current must be less than 2 A. The contact resistance of the distributor system may not exceed 0.25 Ω and the contact resistance of the battery switch shall not exceed 0.10 Ω. The resistance of the uncaging solenoid shall fall in the range of 24 ± 2.0 Ω and the pull-in voltage of the solenoid shall not exceed 18 volts.

2.9 Warhead Detonators.

The warhead detonator is a stab type detonator functioned by a firing pin-striker that is part of the mechanical fuze of the SS-11 (M22) missile. The firing pin striker is restrained by a pin which shears upon receipt of a specified amount of sustainer chamber pressure. Impact with the target causes the unrestrained firing pin-striker to stab the detonator and function the warhead. The kinetic energy to function the detonator cannot exceed 18 inch-ounces. An empirical way of developing this amount of energy consistently is to drop a firing pin with a mass of 1.5 ounces upon the detonator from a height of 12 inches.

3. RESULTS OF TESTS

Seventy-five AGM22B missiles, from Lot No. 5NAB64, manufactured in 1964, were shipped to LAD in August 1964. In April 1968, 25 missiles were sent to the Tropic Test Site in the Canal Zone, 25 were shipped to the Arctic Test Site in Alaska, and 25 remained at LAD. Each year thereafter, until the sample is depleted, five missiles from each storage location are shipped to Aberdeen Proving Ground (APG) for testing. Two missiles of the five received from each site, are flight tested and the remaining three are used for component analysis and evaluation. Each missile is radiographically analyzed and also given a thorough visual inspection and an electrical checkout. None of the missiles, or their component parts, displayed any serious visual defects or shortcomings which would have precluded the tactical capability of the missile. There were no cracks, cavities or voids in the rocket motor propellant or in the warhead charges.

The Electrical Checkout tests of the 15 AGM22B missiles revealed that missiles serial no. S/N 68131 and 68410 had open circuits in the gyro igniter loop. All five missiles from the Canal Zone (TTC) had resistance readings in excess of 2.4 Ω (See Table 3.1) for their Rocket Motor Booster Igniter/Flare Igniter circuit. An average resistance reading of [illegible].3[illegible]2 Ω was recorded for the Tropic missiles while the average reading of Flare and Booster igniters stored at LAD was 2.106 Ω. The ATC missiles had an average reading of 2.028 Ω for the same measurement.

The missiles which gave evidence of open gyro igniters were disassembled and carefully examined to determine why the open circuit existed. Both igniters were intact but the connecting wires and terminals were crumbled from corrosion. Careful examination of the Rocket Motor Booster Igniters of missiles S/N 68131, 68324, 68410, and 68475 likewise showed wires which were broken as a result of long term corrosion. The reason for the high resistance readings during checkout was the presence of the flares which were shunted across the open igniter terminals. In missile S/N 68475, one of the two parallel wire release coils was open thereby causing the resistance reading to double in value.

The open circuits were found only in the missiles which had been stored at the Canal Zone. Desiccant was not placed into the missile containers at any time during their storage life. The high humidity, warm, moist climate, and high salt outfall of the storage site are conductive to severe corrosion of wire, solder joints, and all uncoated metal surfaces.

3.1 Batteries.

Missile batteries from Lot 159B were stored with the missiles at the three storage sites. Ten batteries were selected from each storage site for fourth cycle tests. The batteries are of a "dry cell" storage type and have quite a limited shelf life. None of the batteries which were tested during third cycle evaluations met requirements of the field battery test or the discharge test. It was decided to assign a low priority to fourth cycle tests until a decision was forthcoming on the recommendation to discontinue testing batteries from lot 159B. The lot was manufactured in November 1967. Since dry cell batteries deteriorate with age it was assumed that an additional year of storage could only make the unacceptable batteries worse.

Results of a special battery test which was conducted on five lots of batteries conclude that useful battery shelf life is from 12 to 18 months.

3.2 Guidance Wire Bobbins.

Resistance measurements of 18 guidance wire bobbins ranged from 26,900 Ω to 29,700 Ω. The readings were well within the 30,300 + 4700 Ω requirement. Average resistance was 27,870 Ω and the standard deviation was 925.2 Ω.

Insulation resistance readings, taken with a 200 volt dc potential applied, varied from 29 megohms to 800 megohms. Minimum acceptance requirements are 20 megohms. Results of these tests are listed in Table 3.2. All guidance wires would have performed in a satisfactory manner if they were used for a tactical mission. Fourth cycle results compare favorably with results of the three previous test cycles.

3.3 Flares.

Flare igniter resistance varied from 0.89 Ω to 1.07 Ω for the 18 test items (Table 3.3). The readings were within the specified limits of 0.60 Ω to 1.20 Ω. Average igniter resistance was 0.993 Ω with a standard deviation of 0.05005 Ω.

The igniter activation current was found to range from 0.50 A to a maximum of 0.65 A. (Table 3.3). The maximum current allowed is 0.75 A. Average activation current was 0.597 A with a standard deviation of 0.0401 A.

Seventeen flares were successfully ignited and provided an intensity well above the 5000 candlepower requirement (Table 3.4). Flare S/N 68170 R failed to burn due to misalignment of the igniter with the pyrotechnic mixture. This condition was likewise found in a flare of the second cycle as well as a flare from the third cycle. The missile from which the flare had been removed was stored at LAD, but the defect is attributed to a manufacturing problem rather than an environment induced condition. Since the other flare of missile S/N 68170 operated satisfactorily, a tactical success would have been assured in a firing situation. Average burning time of the flares was 23.67 seconds and exceeded the 21-second minimum requirement. Data showing the luminous intensity of the flares in candlepower at 2 second intervals are listed in Table 3.3.A.

3.4 Wire Release Devices.

Resistance measurements of 18 wire release igniters varied between 1.68 and 2.47 Ω. An average value of resistance was found to be 1.99 Ω with a standard deviation of 0.1878 Ω.

Igniter activation was accomplished by application of a gradually increasing (ramp) current. The energy or level of current required varied from 0.27 to 0.37 A. These values were well within the required 0.50 A maximum. Average activation current was 0.31 A with a standard deviation of 0.0314 A. Complete data for wire release device measurements is listed in Table 3.4. The entire sample would have functioned adequately in a tactical application.

3.5 Explosive Cartridges.

Eighteen explosive cartridges were evaluated in a manner similar to the wire release devices. The range of igniter resistance readings was from 1.63 Ω to 2.32 Ω, well within the 2.05 ± 0.55 Ω requirement. Average igniter resistance was 1.865 Ω and a standard deviation of 0.2835 Ω.

Explosive cartridge activation current varied from 0.27 A to 0.34 A. These readings were less than the 0.50 A maximum tolerance

limit. Average activation current was 0.315 A with a standard deviation of 0.0165 A.

The data does not indicate any significant degradation or deterioration as a result of environment or age. Complete results of each test are listed in Table 3.5. The readings compare favorably with data generated in previous test cycles.

3.6 Decoders.

Individual pitch and yaw signals are extracted by the decoder from the composite guidance command signal. A special test fixture was designed and fabricated to determine how well the decoders extract guidance signals.

The control stick unit mounts in the fixture in such a way that the control stick is restricted to travelling in a straight line forward, rearward, left, or right directions. A plate, which has two equal and intersecting slots perpendicular to each other, is used to assure equal movement in any of the four directions at any given time. Movement of the control stick to the extremity of the slots provides standard pitch (up or down) and yaw (right or left) signals.

All nine decoders produced proper output signals corresponding to the known control stick positions. Yaw outputs of the decoder are designated D&G. In all cases, a yaw left position to the control stick produced a high voltage output at G and a low voltage output at D. A yaw right position of the control stick resulted in a high voltage at D and a low voltage at G. Pitch outputs from the decoder are designated B and H. A high voltage output at B and a low voltage output at H resulted from a pitch-up command. A pitch-down command produced a high voltage at B for one third of the time and low voltage at B for the remaining period. Output at H varied in an opposite but proportional manner. All the above conditions are normal. What would appear to be a discrepancy in the pitch-down signal is due to the incorporation of a 35 percent pitch-up command with the control stick in the neutral position to produce a "nose up" altitude of the missile in flight.

Peak-to-peak decoder voltage outputs at B, D, G, and H, were measured using a cathode ray oscilloscope. It was decided to use a decoder supply voltage of 9 volts dc instead of the nominal 16 vdc to simulate minimum acceptable missile battery conditions. This would give an indication of how a good missile would respond when powered by a battery which was at the lowest point of acceptance by the battery test set. Eight of the nine decoders gave outputs which were above the 7 volt minimum acceptance level. Results of the decoder tests are listed in Table 3.6.

The decoder of missile S/N 68494 gave normal (7.55 v and 7.50 v) readings for the gray and green output terminals. When the black wire terminal was measured, the output remained at 7.55 for various pitch inputs. When the control stick was held at full up position for 5 seconds, the output finally began to change. There was also no output from the brown wire until the pitch full up command was given for 5 seconds. The reason for this erratic behavior was traced to a defective T7 transistor (NPN type OC140). The weak transistor was part of decoder board D34325 which had been manufactured in November, 1964. Though the transistor was sluggish in responding at 9 volt input, it worked in an acceptable manner when powered by 16 volts dc. The defect would be attributed to poor quality control in manufacture rather than as a result of this missile's Arctic storage environment. The success or failure of this missile would depend on the missile battery output level. The missile would tend to fly down and would not respond too readily when the gunner made an attempt to steer up. The longer the range and time of flight, the less likely the response to pitch up commands would be experienced by the gunner as a result of low battery voltage.

3.7 Deflector Assemblies.

Each missile deflector assembly contains eight electromagnetic coils. The coil resistances of each missile were measured to be from 3.95 to 41.2 Ω, well within the required 40 ± 3 Ω limit. Average resistance of all 72 readings was 40.20 Ω with a standard deviation of 0.432483 Ω.

The energizing or "pull-in" voltage of the 72 electromagnetic coils varied from 4.47 Ω to 6.45 Ω. All readings were within the 7 volt maximum requirement. The most severe test would have been a decoder with an output of 7.45 volts and an electromagnetic coil requiring 6.45 votls to pull in. The decoders were capable of supplying deflector assembly demands with a 9 volt input test level. It is very unlikely that a battery would drop to as low as 9 volts. Average pull-in voltage recorded was 5,489 volts and the standard deviation was 0.4443 volts.

The current required to operate the electromagnetic coils ranged from 118 to 156 milliamperes. The upper tolerance level is 170 ma. Average current required by the coils was 134.94 ma and the standard deviation was found to be 10.53 ma.

Complete results of all deflector assembly tests are found in Table 3.7. All deflector assemblies would have operated properly in a tactical firing test.

3.8 Gyroscope and Distributor Assembly.

A photoelectric diode was used to measure the rotational velocity of the seven gyroscopes which were capable of being functioned.

The diode detected the interruption of the light beam as a result of a black stripe which had been painted on the gyro's rotating mass. The detected signal was coupled to an electronic counter which gave a reading at 2-second intervals In this manner the gradual decrease in rotational velocity could be accurately measured.

The seven gyroscopes which were successfully functioned, attained velocities well above the 40,000 rpm requirement. The minimum velocity after 21 seconds requirement of at least 35,000 rpm was surpassed by all seven gyroscopes. Data obtained from the gyroscope tests is presented in Table 3.8A. A graph, plotted for each 2-second interval of velocity, is shown in Figure 3.1.

The gryoscopes from missiles S/N 68131 and S/N 68410 could not be functioned because of an open circuit condition in the gyro igniter circuit. Disassembly and investigation of these gyros revealed that the squibs or igniters were intact and well within the normal 2 to 5 Ω range of resistance. Actual readings of the two igniters were 3.59 and 3.62 Ω. Examination of the solder lug or terminal which was used as a tie point for the igniter and connecting wires revealed that corrosion had attacked the solder joint and caused it to crumble and deteriorate. The connecting wire was lying loosely inside the terminal eye and was not held by the solder at all. Pressure on this point caused continuity to be restored once more in the igniter circuit. Both missiles had been stored in the hot, humid, and salt laden environment of the Canal Zone and it is quite obvious that the failures were the result of long exposure to the adverse environment. The resistance of the remaining seven gyro igniter circuits varied from 3.32 to 3.60 Ω with an average resistance of 3.46 Ω.

The gyro activation detonators (igniters) were functioned by a gradual increased (ramp) current. Function level was recorded by an oscillograph. Current required to function the seven detonators had a range from 1.45 to 1.55 A. These values were well below the 2 A maximum limit. Average current was 1.514 A. The activation detonator current of the remaining two gyros could not be measured due to the previously noted open circuit condition.

Uncaging solenoid coil resistance was measured using a commercial Wheatstone Bridge. Resistance measurements were found to be from 22.5 to 23.9 Ω, well within the 24 $\pm$ 2 Ω requirement. Average resistance was 23.28 Ω which is comparable to results of previous test cycles.

The pull-in voltage was determined by the gradual increase of supply voltage until the solenoid was actuated. Seven solenoids had normal actuation voltages but the remaining two were so badly galled and corroded that normal actuation was not possible. The actuation voltages ranged from 9.4 to 13.1 vdc, well within the maximum acceptance level of 18 vdc. Average pull-in voltage was determined to be 11.4 vdc. Gyroscopes from missiles S/N's 68131 and 68410, which were previously

noted as being severely corroded, had excessive corrosion on the armatures of the uncaging solenoids. This corrosion on the armature caused an excessively high pull-in voltage (31.0 volts) to finally actuate the solenoid of the gyro of missile S/N 68131. Even though a second and third actuation only required 14.5 vdc (movement was unrestricted), this solenoid would not have uncaged its gyro in a tactical situation because voltages in excess of 24 to 28 volts would not be available. The gyro from missile S/N 68410 did not move even though a voltage as high as 90 volts was applied. Both these gyros had two defective conditions which were caused by two differing effects of corrosion. Both defects were directly attributed to the storage environment of the Canal Zone.

Battery switch and gyro distributor assembly contact resistance were measured by application of a constant current through the closed contacts and measuring the resultant potential drop. Resistance of the contacting surfaces was calculated using Ohm's Law. Contact resistances of all battery switches and 33 of 144 distributor contacts were above the specified upper limits of 0.10 Ω and 0.25 Ω respectively. Battery switch contact readings varied from 0.102 Ω to 0.520 Ω. The reading for battery switch contact resistance of missile S/N 68410 was not available due to the inability to release the "stuck" solenoid armature. Average contact resistance for the eight remaining battery switches was 0.2698 Ω. Contact resistance readings varied from 0.10 to 0.97 Ω.

The contact resistances of the distributor assemblies ranged from 0.10 Ω to 0.98 Ω. Average contact resistance was 0.215 Ω with a standard deviation of 0.181 Ω. The high contact resistances are comparable to previous test cycle results and are difficult to interpret and evaluate due to the extremely unsettled nature of the contact resistance while the gyroscope is spinning. It is concluded that these circuits would perform satisfactorily in tactical use despite the relatively high resistance readings. Results of the distributor assembly contacts are listed in Table 3.8B and 3.8C.

3.9 Warhead Detonators.

All nine warhead detonators functioned in an acceptable manner when acted on by a force which was equivalent to 18 inch-ounces of kinetic energy. A firing pin, having a mass of 1.5 ounces, was dropped from a height of one foot to impart the required kinetic energy. From the results it is very likely that all warheads would have been detonated when required.

4. CONCLUSIONS AND RECOMMENDATIONS

Two missiles, S/N 68131 and S/N 68410, would have failed to launch in a tactical situation due to their open igniter circuits. Prolonged storage in the Canal Zone without the benefit of desiccant severely degrades missile quality to the point of failure. As the storage

time increases, the effects of corrosion become more severe in the Tropic environment. It is likely that the 5th Cycle Tropic missiles will be almost completely unusable as a consequence of the accumulative corrosion effects arising from the detrimental storage environment of the Canal Zone. The problem areas which have already been noted will increase in number and severity. The one missile from the Arctic site, S/N 68494, which had a marginal pitch output at 9 volts would have operated normally at the nominal 16 volt output of a good battery. None of the batteries tested in the third cycle met specified minimum requirements. These batteries were not tested during fourth cycle tests. It is likely they would be degraded further with age and environmental exposure. Except to indicate the likely further degradation of the batteries, it is recommended that fifth cycle battery tests be omitted.

It is recommended that an additional sample of AGM22B missiles be sent to the Canal Zone with desiccant placed in the containers. The desiccant would be changed at regular intervals, quarterly or semi-annually to maintain a "dry" missile atmosphere. Results of this test would tell us how well the AGM22B can withstand Tropic environment when stored properly in a suitable container.

A technique for isolating the rocket motor igniter circuit from the Flare igniter circuit without disassembly was devised during fourth cycle tests. A high resistance reading for the Rocket Motor/Flare igniter measurement gave some indication of a possible open igniter circuit. Positive identification could not be made without disassembly of the missile. With the new technique, the rocket motor igniter is isolated from the flare igniter which is normally shunting (in parallel with) the circuit under tests. An open igniter is detected from an open circuit reading rather than from a reading that is several ohms above normal. Using this technique, troubles can be detected thereby preventing any attempt to launch a missile which has an open rocket motor igniter. This measurement will be utilized during all future tests as well as all fifth cycle measurements.

Six of the 15 missiles which comprised the test sample were set aside and used for firing tests. Two of the remaining nine missiles which were tested and evaluated in the laboratory would have been tactical failures. Any attempt to fire either of the two missiles would result in a hangfire resulting in the missile not leaving the launcher.

TABLE 3.1 AGM22B MISSILE ELECTRICAL CHECKOUT TEST RESULTS (4TH CYCLE)

MISSILE SERIAL NUMBER	STORAGE LOCATION	GYRO IGNITER CIRCUIT (OHMS)	GYRO UNCAGING SOLENOID (OHMS)	FLARE/ BOOSTER IGNITER CIRCUITS (OHMS)	WIRE RELEASE IGNITER CIRCUITS (OHMS)
68020	LAD	3.57	21.91	2.05	3.58
68170		3.42	21.68	1.96	3.54
68253		3.38	22.06	2.06	3.55
68405		3.40	21.58	1.98	3.48
68560		3.53	21.13	2.03	3.58
$\bar{X}$		3.460	21.672	2.016	3.546
67998	ATC	3.58	21.70	2.00	3.50
68408		3.54	21.67	2.01	3.55
68472		3.32	21.72	2.07	3.55
68494		3.47	22.18	2.03	3.61
68536		3.13	21.53	2.03	3.60
$\bar{X}$		3.408	21.760	2.028	3.562
68131	TTC	OPEN[a]	22.21	3.18[bc]	3.88
68324		3.47	21.19	4.00[bc]	3.85
68410		OPEN[a]	21.61	3.16[bc]	3.68
68475		3.92	21.69	3.26[bc]	7.62[bd]
68517		3.49	21.61	3.21[b]	3.73
$\bar{X}$		3.627	21.662	3.362	3.785

a. The Gyroscope Igniters from missiles S/N 68131 and 68410 were found to be Open due to corrosion in subsequent investigations.

b. Resistance readings above the upper original acceptance specification

c. The Rocket Motor Booster Igniter forom missile, S/N 68131, 68324, 68410, and 68475 were found to be Open due to corrosion in subsequent investigations.

d. One of the two parallel wire release circuits was Open in

TABLE 3.2 AGM22B GUIDANCE WIRE BOBBIN TEST RESULTS (4TH CYCLE)

SAMPLE NO.	MISSILE S/N	CIRCUIT RESISTANCE K Ω	INSULATION RESISTANCE @ 200 Vdc
1	68020 (T)	29.2	450
2	68020 (B)	27.5	300
3	68131 (T)	27.5	100
4	68131 (B)	26.9	100
5	68472 (T)	27.2	200
6	68472 (B)	28.8	150
7	68408 (T)	27.3	300
8	68408 (B)	27.1	500
9	68324 (T)	28.7	150
10	68324 (B)	28.8	80
11	68170 (T)	27.6	225
12	68170 (B)	28.5	320
13	68410 (T)	28.9	39
14	68410 (B)	29.7	60
15	68494 (T)	27.0	290
16	68494 (B)	27.0	800
17	68253 (T)	27.2	200
18	68253 (B)	26.9	320

$\bar{X} = 27.87$

$s = .925\ k\Omega$

TABLE 3.3 AGM22B FLARE TEST RESULTS (4TH CYCLE)

SAMPLE NO	MISSILE S/N	IGNITER RESISTANCE (OHMS)	FIRING CURRENT (AMPERES)	BURN TIME (SECONDS) CP>5000
1	68020L	1.07	0.55	24.0
2	68020R	1.01	0.55	25.0
3	68170L	0.98	0.60	22.3
4	68170R	1.00	0.65	DUD
5	68253L	0.99	0.60	22.7
6	68253R	0.90	0.65	23.2
7	68408L	1.05	0.60	24.4
8	68408R	1.00	0.60	23.0
9	68472L	0.89	0.60	24.9
10	68472R	0.95	0.65	23.6
11	68494L	0.99	0.60	23.9
12	68494R	0.97	0.65	23.0
13	68324L	1.05	0.60	23.0
14	68324R	1.00	0.60	24.8
15	68131L	1.02	0.50	22.7
16	68131R	0.96	0.60	23.1
17	68410L	1.07	0.55	24.7
18	68410R	0.98	0.60	24.1
	s = .24766	$\bar{X}$ = 0.993	$\bar{X}$ = 0.597	$\bar{X}$ = 23.67

TABLE 3.4 - AGM 22B FLARE LUMINOUS INTENSITY IN CANDLEPOWER (X1000) AT 2-SECOND INTERVALS

MISSILE S/N	1	3	5	7	9	11	13	15	17	19	21
68020	16.0	15.2	15.2	16.0	15.2	14.8	15.2	15.2	17.6	16.8	16.8
68020	15.2	14.4	12.8	16.8	15.2	14.4	14.8	15.2	16.0	16.0	16.8
68170	18.4	18.4	16.8	17.6	19.2	18.4	18.4	18.4	18.4	18.4	17.6
68170 DUD											
68253	16.8	16.0	16.8	16.8	16.0	16.0	16.8	17.6	16.8	18.4	18.4
68253	15.2	14.4	14.4	14.4	14.8	14.8	14.4	13.6	14.0	13.6	14.4
68408	14.8	15.2	14.0	14.0	14.4	14.4	14.0	15.2	15.2	15.2	15.2
68408	14.4	14.8	14.0	15.2	15.2	15.2	14.8	14.8	15.2	14.8	15.2
68472	14.4	15.2	15.2	14.4	14.0	14.0	14.0	14.0	14.0	14.0	14.4
68472	14.8	16.0	15.2	14.0	14.8	16.0	16.8	15.2	14.8	16.0	15.2
68494	15.2	14.4	14.0	15.2	16.0	16.0	16.0	15.2	15.2	15.2	16.8
68494	17.6	18.4	18.4	17.6	17.6	16.8	16.8	16.8	16.8	17.6	17.6
68324	16.8	16.0	16.0	15.2	15.2	16.0	16.8	17.6	16.8	16.8	16.8
68324	16.8	17.6	13.6	14.0	14.8	16.0	16.8	16.8	16.8	16.0	16.0
68131	16.8	16.8	16.8	16.0	16.0	18.4	16.8	16.0	16.8	16.8	16.0
68131	16.0	16.0	15.2	15.2	15.2	14.8	14.8	16.0	16.0	16.8	16.0
68410	16.0	16.8	13.6	14.4	14.0	14.8	15.2	16.0	16.0	16.0	15.2
68410	16.0	16.0	15.2	16.0	16.8	16.8	14.4	14.8	14.0	14.4	14.4
$\bar{X}$	15.95	15.98	14.84	15.46	15.55	15.74	15.65	15.79	15.91	16.05	16.05

TABLE 3.4A - AGM22B WIRE RELEASE DEVICE TEST RESULTS (4TH CYCLE)

SAMPLE NO.	MISSILE S/N	RESISTANCE (OHMS)	FIRING CURRENT (AMPERES)
1	68020	1.90	0.30
2	68020	2.06	0.30
3	68131	2.40	0.29
4	68131	2.01	0.31
5	68472	1.92	0.27
6	68472	1.90	0.35
7	68408	2.00	0.36
8	68408	1.82	0.30
9	68324	1.94	0.31
10	68324	2.12	0.37
11	68170	1.89	0.34
12	68170	1.97	0.30
13	68410	2.47	0.27
14	68410	1.86	0.28
15	68494	2.02	0.33
16	68494	2.00	0.36
17	68253	1.68	0.34
18	68253	1.94	0.30

$\bar{X} = 1.99$ $s = .1878$ $\bar{X} = 0.31$ $s = .0314$

TABLE 3.5 - AGM22B EXPLOSIVE CARTRIDGE TEST RESULTS (4TH CYCLE)

SAMPLE NO.	MISSILE S/N	RESISTANCE (OHMS)	FIRING CURRENT (AMPERES)
1	68020	1.71	0.30
2	68131	2.10	0.32
3	68472	2.32	0.32
4	68408	1.78	0.33
5	68324	2.01	0.32
6	68170	1.72	0.34
7	68410	1.83	0.27
8	68494	1.65	0.30
9	68253	1.63	0.31
10	*68405	1.70	0.33
11	*68517	2.06	0.30
12	*68475	1.77	0.32
13	*67998	2.13	0.32
14	*100785	1.70	0.30
15	*100379	1.80	0.31
16	*100858	1.85	0.33
17	*68560	1.80	0.33
18	*68536	2.02	0.32

$\bar{X}$ = 1.865   s = .2835 $\bar{X}$ = .3150   s = .0165

*From Flight Test Rounds

TABLE 3.6 - AGM22B DECODER PEAK-TO-PEAK OUTPUT VOLTAGES USING A SUPPLY VOLTAGE OF 9 VOLTS

	MISSILE S/N	GRAY D	BLACK B	GREEN G	BROWN H
1	68020	7.60	7.60	7.55	7.55
2	68131	7.60	7.60	7.55	7.50
3	68170	7.55	7.55	7.50	7.50
4	68253	7.55	7.55	7.50	7.55
5	68324	7.55	7.55	7.45	7.45
6	68408	7.55	7.60	7.45	7.45
7	68410	7.55	7.55	7.50	7.50
8	68472	7.55	7.55	7.50	7.50
9	68494	7.55	a	7.50	b

D34325 Mfg. 11/64 T7 transistor (NPN type OC140) defective

$\bar{X}$ = 7.5611 $\bar{X}$ = 7.5687 $\bar{X}$ = 7.500 $\bar{X}$ = 7.500

Supply Voltage = 16V (Normal output about 14 volts)

	GRAY	BLACK	GREEN	BROWN
1	13.5	13.5	13.5	13.5
2	13.5	13.5	13.5	13.5
3	13.5	13.5	13.5	13.5
4	13.5	13.5	13.5	13.5
5	13.5	13.5	13.5	13.5
6	13.5	13.5	13.5	13.5
7	13.5	13.5	13.5	13.5
8	13.5	13.5	13.5	13.5
9	13.5	13.5	13.5	13.0

a. Output did not change at all for different pitch inputs stated at 7.5V until control stick was held at full UP for at least 5 seconds.

b. No output until after pitch full UP command was given for at least 5 seconds.

TABLE 3.7A - AGM22B THRUST DEFLECTOR ASSEMBLY TESTS (4TH CYCLE)

RESISTANCE OF ELECTROMAGNETIC COILS
(OHMS)

SAMPLE NUMBER	SERIAL NUMBER	R1	S1	R2	S2	R3	S3	R4	S4
1	68324	39.9	40.4	41.2	41.0	40.8	41.0	40.0	41.1
2	68410	39.7	39.8	40.0	41.0	40.2	40.3	40.2	40.1
3	68494	40.5	39.9	40.2	40.5	39.7	40.8	40.2	40.5
4	68253	39.8	40.1	39.7	39.8	39.5	40.3	39.6	40.0
5	68131	40.7	40.1	40.0	40.6	39.7	40.2	40.1	40.2
6	68472	40.4	40.6	40.1	40.0	39.9	39.8	40.2	41.0
7	68170	39.9	39.3	39.8	40.0	40.2	39.8	40.0	40.3
8	68408	40.4	39.9	40.5	40.9	40.0	40.4	39.5	39.9
9	68020	40.7	40.0	40.7	39.9	40.8	39.7	39.8	40.6

$\bar{X}$ = 40.20

s = .432483

TABLE 3.7B - PULL-IN VOLTAGE OF ELECTROMAGNETIC COILS
(VDC)

SAMPLE NUMBER	SERIAL NUMBER	R1	S1	R2	S2	R3	S3	R4	S4
1	68324	5.35	5.68	5.48	6.10	5.70	6.40	5.49	6.45
2	68410	5.45	5.35	5.45	6.08	5.17	5.54	5.81	5.73
3	68494	5.00	5.88	4.79	5.08	4.95	6.08	4.50	5.67
4	68253	5.04	5.95	5.45	5.58	5.60	5.80	5.57	5.80
5	68131	5.79	5.98	6.00	6.26	5.80	5.60	5.49	6.28
6	68472	5.23	5.77	4.65	5.70	5.14	5.33	4.70	5.64
7	68170	5.02	5.55	4.47	5.55	4.90	5.74	5.05	5.37
8	68408	5.60	5.45	5.47	6.00	4.98	5.50	5.08	5.70
9	68020	4.95	5.89	5.23	5.41	4.85	5.28	4.88	5.97

$\bar{X} = 5.4891$ $s = 0.4443$

TABLE 3.7C - PULL-IN CURRENT OF ELECTROMAGNETIC COILS (DCMA)

SAMPLE NUMBER	SERIAL NUMBER	R1	S1	R2	S2	R3	S3	R4	S4
1	68324	130	139	133	147	140	156	137	156
2	68410	135	132	135	146	127	136	143	141
3	68494	123	146	118	125	124	147	111	138
4	68253	125	147	135	139	140	142	139	143
5	68131	141	147	148	152	144	137	135	154
6	68472	129	139	115	140	124	131	115	135
7	68170	125	139	112	137	121	142	125	132
8	68408	137	135	134	144	123	134	127	141
9	68020	121	146	128	135	118	132	122	145

$s = 10.53$ $\bar{X} = 134.94$

TABLE 3.8A - RESULTS OF AGM22B MISSILE GYROSCOPE TESTS (4TH CYCLE)

SAMPLE NO.	MISSILE S/N	IGNITER RESISTANCE (OHMS)	FIRING CURRENT (AMPERES)	ROTATIONAL VELOCITY IN K RPM/2-SECOND INTERVAL													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	68020	3.60	1.55	47.5	46.4	45.4	44.5	43.5	42.6	41.6	40.8	40.0	39.2	38.4	37.6	36.9	36.2
2	68170	3.48	1.50	47.9	46.8	45.9	44.8	43.9	43.0	42.0	41.2	40.4	39.5	38.8	38.0	37.3	36.6
3	68253	3.40	1.55	47.9	47.2	46.1	45.1	44.1	43.2	42.3	41.3	40.6	39.7	38.9	38.2	37.4	36.7
4	68408	3.52	1.45	48.1	47.0	45.9	44.9	43.9	43.0	42.1	41.2	40.4	39.5	38.8	38.0	37.3	36.6
5	68472	3.32	1.50	48.1	47.0	46.0	45.0	44.0	43.1	42.2	41.3	40.4	39.6	38.8	38.1	37.4	36.7
6	68494	3.44	1.50	47.2	46.2	45.1	44.2	43.2	42.3	41.4	40.6	39.8	38.9	38.2	37.4	36.7	36.0
7	68324	3.47	1.55	47.8	46.6	45.5	44.4	43.4	42.5	41.5	40.6	39.8	39.0	38.2	37.4	36.6	36.0
8	68131	OPEN	—	COULD NOT BE FUNCTIONED DUE TO OPEN IGNITER WITHIN GYRO ROTOR													
9	68410	OPEN	—														
		$\bar{X}$ = 3.461	1.514	47.79	46.74	45.70	44.70	43.71	42.81	41.87	41.00	40.20	39.34	38.59	37.81	37.09	36.40

TABLE 3.8B - RESULTS OF TESTS CONDUCTED ON AGM22B GYRO SOLENOID AND SWITCH ASSEMBLY (4TH CYCLE)

SAMPLE NUMBER	MISSILE S/N	COIL RESISTANCE (OHMS)	PULL-IN VOLTAGE (VDC)	CONTACT RESISTANCE (OHMS)
1	68020	23.8	10.5	0.334
2	68170	23.1	13.1	0.102
3	68253	23.2	9.8	0.277
4	68408	23.3	11.5	0.285
5	68472	23.3	12.7	0.520
6	68494	23.9	9.4	0.133
7	68324	23.0	12.8	0.238
8	68131	22.5	31.0	0.340
9	68410	23.4		
		$\bar{X}$ = 23.28	$\bar{X}$ = 11.4	$\bar{X}$ = 0.2698

TABLE 3.8C - AGM22B GYROSCOPE DISTRIBUTOR CONTACT RESISTANCE TEST RESULTS (4TH CYCLE)

COMMUTATOR		SLIP RING GREEN	BLACK	GRAY	BROWN
68020	G/W	.10	.15	.10	.10
	B/W	.15	.15	.10	.15
	Gray/White	.10	.10	.15	.10
	Brn/W	.10	.10	.10	.20
68170	G/W	.15	.10	.10	.15
	B/W	.10	.20	.15	.14
	Gray/White	.15	.16	.15	.14
	Brn/W	.14	.15	.16	.14
68253	G/W	.15	.34	.16	.19
	B/W	.16	.25	.70	.18
	Gray/W	.14	.16	.18	.28
	Brn/W	.15	.16	.14	.26
68408	G/W	.12	.14	.15	.14
	B/W	.15	.38	.16	.17
	Gray/White	.65	.15	.70	.55
	Brn/W	.14	.12	.13	.15
68472	G/W	.12	.15	.41	.45
	B/W	.11	.12	.11	.85
	Gray/White	.14	.10	.12	.32
	Brn/W	.13	.11	.28	.35
68494	G/W	.10	.12	.14	.13
	B/W	.14	.11	.13	.12
	Gray/W	.11	.10	.14	.13
	Brn/W	.10	.11	.11	.12
68324	G/W	.52	.12	.11	.13
	B/W	.33	.11	.12	.38
	Gray/W	.25	.34	.15	.30
	Brn/W	.13	.12	.10	.19
68131	G/W	.12	.12	.13	.84
	B/W	.10	.13	.29	.32
	Gray/W	.11	.10	.97	.12
	Brn/W	.15	.85	.12	.98
68410	G/W	.10	.11	.12	.10
	B/W	.20	.55	.43	.19
	Gray/W	.11	.10	.44	.52
	Brn/W	.30	.34	.36	.48

$\bar{X} = .215$ $S = .1818$

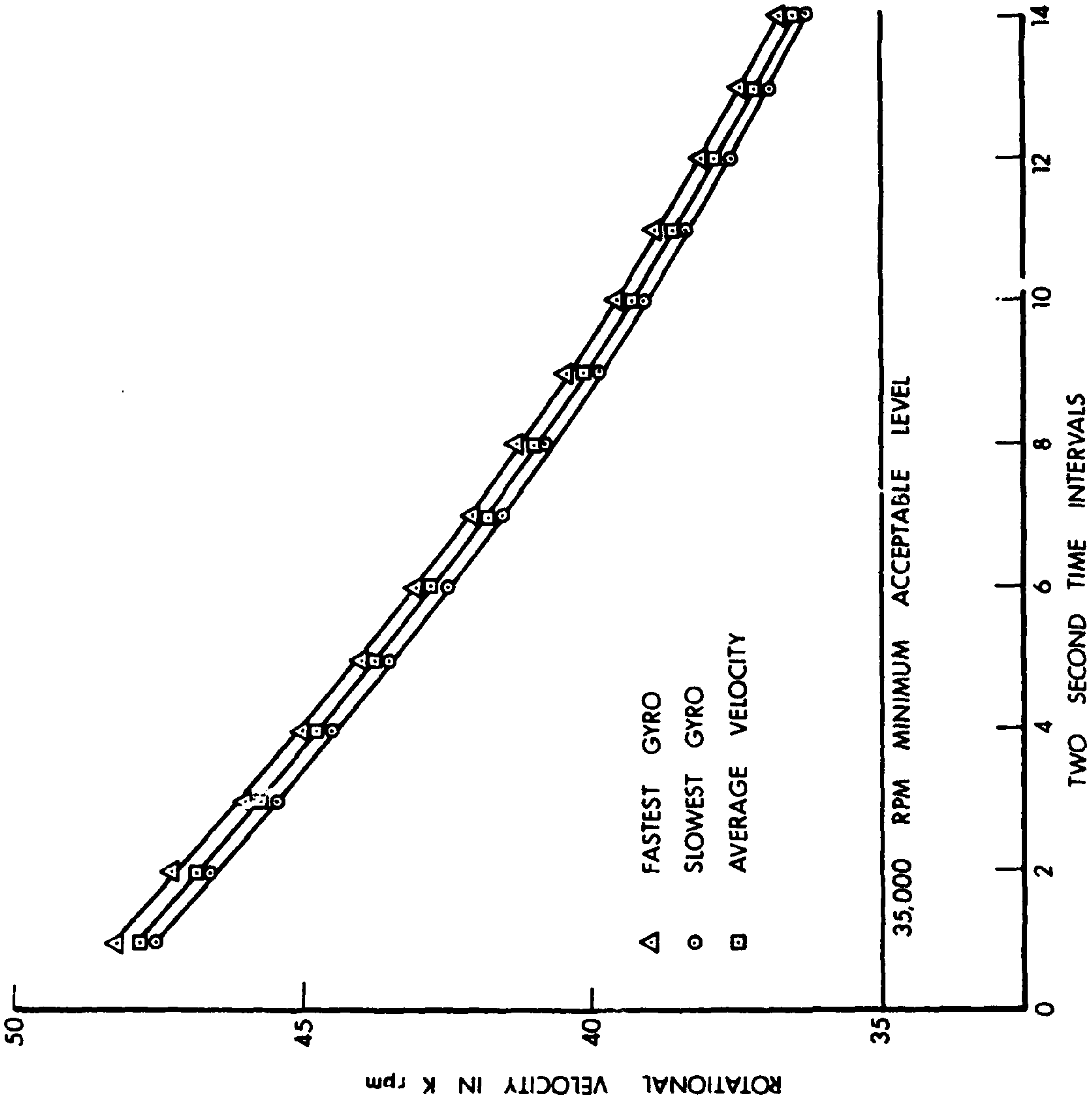

Figure 1. Gyroscope Rotational Velocity vs Time.

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